3D Multi-material Interface Reconstruction on Generalized Polyhedral Meshes

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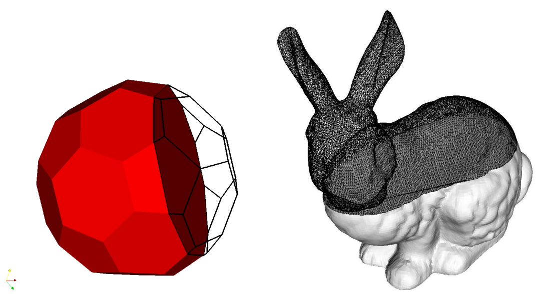
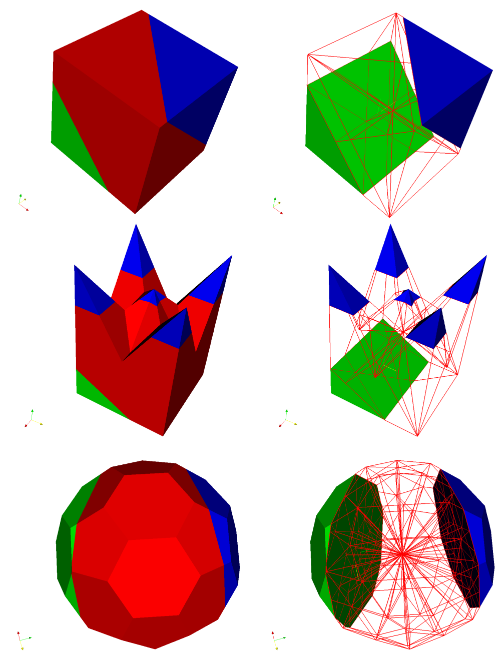
Interface reconstruction is an essential step in volume-tracking multi-material flow simulations for accurate prediction of dynamic behavior of multi-material flow.



Intersection of complex polyhedra. Left shows 32 faced truncated icosahedron, and right shows 725,000 faced bunny mesh. Both surface mesh represents a polyhedron.



Generalized polyhedral cells with multi-materials (red, green, and blue). Top row shows hexahedral cell, middle row shows non-convex *enneahedron (obtained by subdividing top face of hexahedron and disturbing the vertices on the faces), and bottom row represents truncated icosahedron. Left column show solid view, and right column show the wire-frame view of the solid which revels the sub-cell structure.*

We developed multi-material (more than two materials) interface reconstruction methods for 3D meshes of generalized polyhedrons, [1]. The basic information used in interface reconstruction is the volume fraction of each material in mixed cells, that is, those containing several materials.

We describe three methods. The first two methods represent an extension of standard piece-wise linear interface construction (PLIC) methods into 3D and use information only about volume fractions. The first method is first-order accurate and based on the discrete gradient of the volume fraction as an estimate of the normal to the interface. The second method is planarity preserving (second-order accurate) and is an extension to 3D of the least squares volume of fluid interface reconstruction algorithm (LVIRA, see [2] for 2D). The third method is an extension to 3D of the so-called moment of fluid (MoF) method, [3]. The MoF method is second-order accurate. This method uses information not only about volume fractions but also about the position of the centroids of each material. In contrast to standard PLIC methods, the MoF method uses only information from the cell where reconstruction is performed, no information from neighboring cells is needed. Also the MoF method provides automatic ordering of the materials in the process of interface reconstruction. Optimal ordering is based on comparing the positions of the reference and actual (centroids of the reconstructed pure

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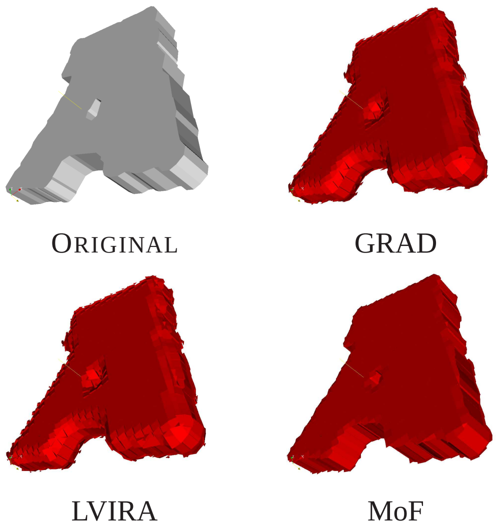

Interface reconstruction of not simply connected material region with sharp corners.

sub-cells) positions of the centroids. The performance of the methods is demonstrated on numerical examples.

Acknowledgements

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References

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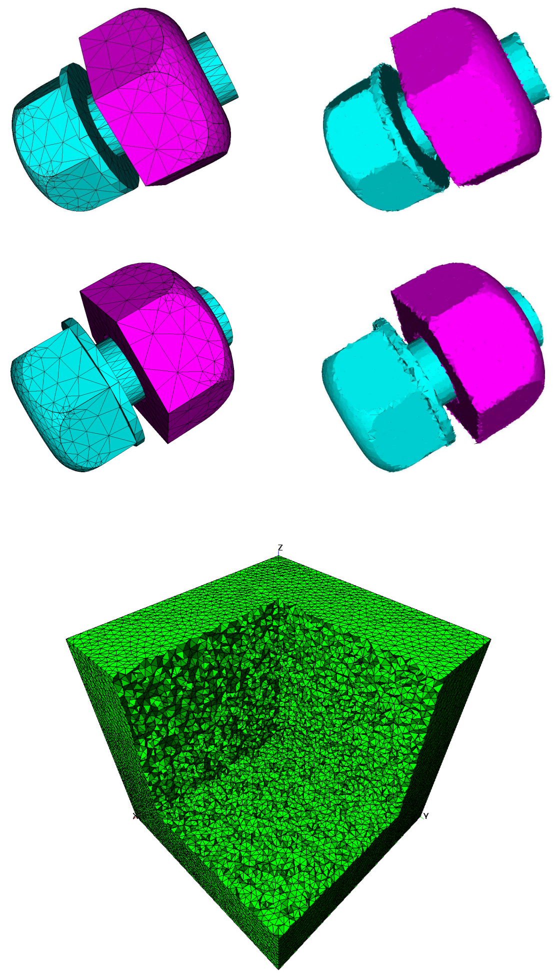

Multi-material ($n_{mat} = 3$, i.e. bolt, nut, and background) interface reconstruction with MoF. Left column shows origianl material region represented by tetrahedral volume meshes, and right column shows its reconstruction with MoF method on unstructured tetrahedral base mesh, shown at the bottom row. Top and middle rows show views in different perspective.